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Methane and carbon dioxide fluxes above a boreal forest observed by true eddy accumulation and eddy covariance

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Forests play an important role in the exchange of greenhouse gases between the land surface and the atmosphere. While the soils of upland forests generally act as methane sinks, there is recent evidence that trees can mediate methane emissions to the atmosphere. However, the net ecosystem exchange of methane and therefore the impact of forests on the atmospheric methane budget remains uncertain.

The current study quantified the net ecosystem exchange of methane (CH_4) and carbon dioxide (CO_2) continuously at 30-min resolution above a boreal forest at Hyytiälä, Finland, from July to December 2017 using two micrometeorological methods. We deployed a new implementation of the true eddy accumulation method, which is perceived to be particularly suitable for detecting small trace gas fluxes due to long signal integration times side-by-side to eddy covariance. To validate the new method, we compared true eddy accumulation CO_2 flux measurements to the conventional eddy covariance CO_2 flux measurements. Results showed that true eddy accumulation CO_2 fluxes matched eddy covariance CO_2 fluxes with R^2 values of up to 0.96.

The forest was most frequently a net sink of methane with shorter periods of net emissions of similar magnitude as the sink strength. In contrast to net CO_2 fluxes, which declined over the period from July to December due to declining assimilation and respiration, the methane fluxes maintained significant magnitude and variance throughout the same period. The true eddy accumulation methane flux estimates showed significantly lower variance and noise compared to closed-path eddy covariance, suggesting a superior signal-to-noise ratio of true eddy accumulation when detecting the small net ecosystem exchange of methane and other trace gases over forests.